FlowStream™

Laminar Mass Flowmeters

User Manual

Series: OFS

Firmware Revision 5.79

UNIVERSAL FLOW MONITORS, INC.
1755 East Nine Mile Road
PO Box 249
Hazel Park, MI 48030-0249
TEL (248) 542-9635 FAX (248) 398-4274
http://www.flowmeters.com

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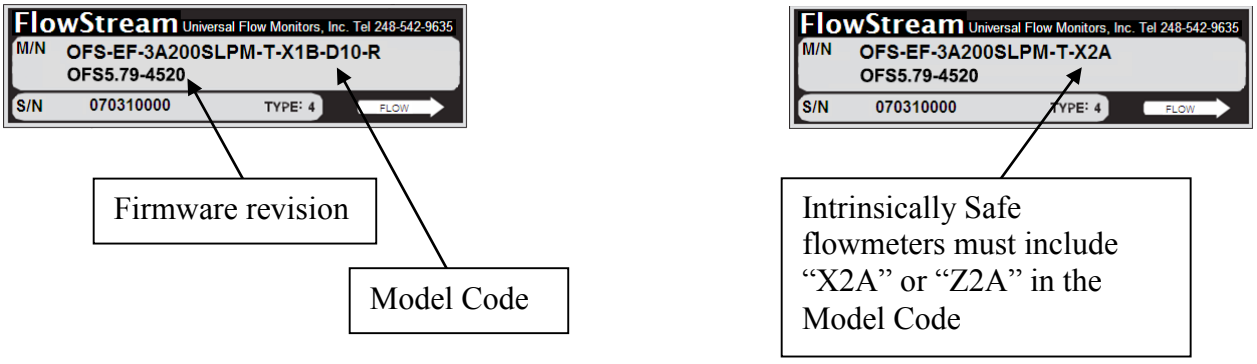
PROPRIETARY NOTICE

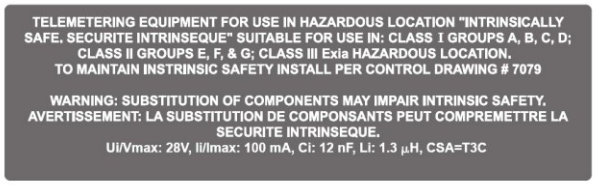
The information contained in this publication is derived in part from proprietary and patented data. This information has been prepared for the express purpose of assisting in installation, operation, and maintenance of the instruments described herein. Publication of this information does not convey any rights of use or reproduction other than in connection with the installation, operation and maintenance of the equipment described herein. Universal Flow Monitors, Inc. reserves the right to change the information contained in this publication at any time and without prior notice.

Serial numbers are formatted as YY MM ID 000
YY = year, MM = month, ID = product identifier, 000 through 999 = three-digit sequential number.

NAMEPLATE EXAMPLE


FlowStream Universal Flow Monitors, Inc. Tel 248-542-9635
M/N OFS-EF-3A200SLPM-T-X1B-D10-R
OFS5.79-4520
S/N 070310000 TYPE: 4 FLOW
Firmware revision
Model Code
FlowStream Universal Flow Monitors, Inc. Tel 248-542-9635
M/N OFS-EF-3A200SLPM-T-X2A
OFS5.79-4520
S/N 070310000 TYPE: 4 FLOW
Intrinsically Safe flowmeters must include "X2A" or "Z2A" in the Model Code

The Intrinsically Safe flow transmitters have the following label:


TELEMETERING EQUIPMENT FOR USE IN HAZARDOUS LOCATION "INTRINSICALLY SAFE. SECURITE INTRINSEQUE" SUITABLE FOR USE IN: CLASS I GROUPS A, B, C, D; CLASS II GROUPS E, F, & G; CLASS III Exia HAZARDOUS LOCATION.
TO MAINTAIN INSTRINSIC SAFETY INSTALL PER CONTROL DRAWING # 7079
WARNING: SUBSTITUTION OF COMPONENTS MAY IMPAIR INTRINSIC SAFETY.
AVERTISSEMENT: LA SUBSTITUTION DE COMPONSANTS PEUT COMPREMETTRE LA SECURITE INTRINSEQUE.
Ui/Vmax: 28V, Ii/Imax: 100 mA, Ci: 12 nF, Li: 1.3 µH, CSA=T3C

GENERAL SPECIFICATIONS

Flow Ranges:	500 SCCM full-scale to 1,000 SLPM full-scale 1 SCFH full-scale to 2,100 SCFH full-scale
Turndown Ratio:	100:1
Maximum Operating Pressure:	100 PSIG
Burst Pressure:	200 PSIG
Pressure Effect on Accuracy:	Less than 0.03% F.S. / PSI
Maximum Operating Temperature:	176 °F (80 ºC)
Minimum Operating Temperature:	-13 °F (-25 ºC)
Temperature Effect on Accuracy:	Less than 0.03% F.S./ °F
Maximum Pressure Drop:	1.5 PSI at F.S. flow (from inlet port to outlet port)
Process Connections:	1/4”-3/8”-1/2”-3/4” NPT female
Wetted Parts	
Sensors:	Glass-filled nylon, alumina-based ceramic, silicon, gold, epoxy
Flow Body Internals:	Anodized aluminum, Viton, stainless steel
Enclosure Rating:	Type 4
Display:	4-digit LCD digital display, 0.35" high
Approvals:	CE, CSA, Intrinsic Safety (all classes and divisions) with proper zener barrier

ELECTRICAL SPECIFICATIONS

Accuracy (Including Linearity and Repeatability)

Flow:	± 1% of full-scale for flowmeters sized from 15-566 SLPM (31-1200 SCFH) of Air ± 2% of full-scale for flowmeters sized for lower than 15 SLPM (30 SCFH) of Air ± 2% of full-scale for flowmeters sized for higher than 566 SLPM (1201 SCFH) of Air
Pressure:	± 1 PSI (See **Note 1**)
Temperature:	± 3 °F
Totalizer:	± 0.25% of full-scale (in addition to flow accuracy)

Output Signal

Analog:	4-20 mA (2-wire loop powered) 0-5 V, 0-10 V, 1-5 V 0-5 V Bi-directional (2.5 V = 0 flow)
Frequency:	0-1000 Hz, 200-1200 Hz 0-3V signal amplitude
Pulse:	1,250-5,000 pulses/minute, user selectable 0-3V pulse amplitude 2 msec pulse width

Response Time:	5 – 100 msec (step response), user selectable
Alarms:	2 independent open-collector outputs (high/low flow rate) with corresponding LEDs
Open-Collector Rating:	30VDC at 50 mA
Electrical Connection:	4- or 7-conductor shielded pigtail cable
Supply Voltage:	10–30 VDC (Standard), 12-24 VDC (Intrinsically Safe) 7.2-9 VDC for battery-operated units (See **Note 2**)
Supply Current:	22 mA @ F.S. flow (includes over-range) for 4-20 mA loop-powered transmitters 5 mA for voltage, frequency, and pulse outputs 3.5 mA for battery-operated units (See **Note 2**)

Note 1: Pressure, temperature, and totalizer are only displayed on the LCD. No output signal is available for these parameters.
Note 2: Battery-operated units require a standard 9V alkaline battery and will operate for over 100 hours continuously. An On/Off switch allows the user to turn the power off, thus conserving the battery life. These flowmeters have no output signal.

OPERATION

FlowStream flowmeters accurately measure the mass flow rate of most gases. The flow rate is determined by measuring the pressure drop across a unique internal restriction, known as Laminar Flow Element (LFE). The restriction is designed such that the gas molecules are forced into moving in parallel paths along the entire length of the passage for the entire range of operation of the device. Unlike other pressure-flow measuring devices, the relationship between pressure drop and flow is *linear* in laminar flowmeters.

FlowStream mass flowmeters utilize an absolute pressure sensor along with a temperature sensor to compensate for density variations of the gas. When combined with the differential pressure (volumetric flow) output, the mass flow rate of the gas can be determined.

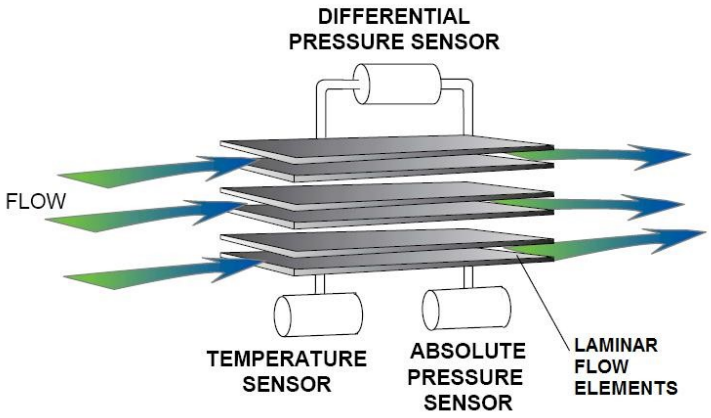


Figure 1. Laminar Flow Illustration

APPLICATIONS

FlowStream flowmeters are designed to work with non-corrosive, non-ionic, clean, dry gases only. Introduction of liquids to the internal sensors will damage the unit, and the repair is not covered under warranty. Relative humidity of the gas can be as high as 100%, as long as proper installation guarantees that no internal condensation will occur. A 50-micron filter and/or dryer may be required for some applications.

Using FlowStream at Varying Temperatures

Even though **FlowStream** flowmeters measure true mass flow, rapid variations in ambient and/or gas temperature may affect performance. This is due to the time lag of the internal temperature sensor and the slow heating and cooling of the flowmeter body. It is highly recommended that through *proper installation* the following two objectives be met:

- There be minimal difference between gas temperature and ambient temperature;
- Rapid temperature variations be avoided.

The internal temperature sensor is located above the inlet port, very close to where the gas enters the meter. This ensures accurate measurement of the gas temperature. However, because the temperature sensor is embedded inside the flowmeter body, if ambient temperature is different from gas temperature, there would be a discrepancy between what the sensor reads and the true gas temperature. The flowmeter body would track ambient temperature while gas temperature would heat/cool the body at a different rate.

Likewise, if temperature variation is rapid, the flowmeter body may not follow it quickly enough due to the mass of the metal flow chamber, which in turn would result in inaccurate measurement of gas temperature.

For optimal performance, always allow two to four hours from the time the ambient and gas temperatures are stabilized to when the first flowmeter reading is taken.

Using FlowStream with Different Gases

FlowStream flowmeters can easily be used to measure the flow rate of other gases, as long as the gas compatibility criteria are observed. For example, a flowmeter that is factory-calibrated for air can be used to measure the flow of Argon. (Consult Factory for additional information.)

Reference Conditions for Mass Flow Measurement

Although the correct units for mass are expressed in grams, kilograms, etc., it has become somewhat standard that mass flow rate is specified in SLPM (standard liters per minute), SCFH (standard cubic feet per hour) or other similar units.

This means that the mass flow rate is calculated by normalizing the volumetric flow rate to some standard temperature and pressure (STP). By knowing the gas density at that STP, one can determine the mass flow rate in grams per minute, kilograms per hour, etc. STP is usually specified at sea level conditions; however, no single standard exists for this convention. UFM uses STP of 70° F and 14.7 PSIA.

Note: If used outside the parameters specified in this manual, the proper operation of the flowmeter cannot be guaranteed.

WIRING DIAGRAM

Wiring for 4-20mA Transmitters

Figure 2 shows a typical 2-wire, 4-20mA transmitter wiring for use with **FlowStream** flowmeters. Maximum loop resistance is related to the available supply voltage. Since the flowmeter requires 10 volts to operate, the voltage drop across the loop resistance at full-scale flow output (20mA) must be added in to determine the minimum supply voltage. For example, if a 100-ohm resistor is used to convert the current signal to voltage, the voltage drop across the resistor will be 0.4-2 volts for 4-20 mA, respectively. Minimum required loop voltage in this case is 12 volts, as shown. Likewise, the voltage drop for a 250-ohm resistor is 1-5 volts, requiring a minimum of 15 volts supply. Please refer to the graph in **Figure 3**.

Wire Color	Function	
Red	Supply +	12-30VDC (Standard) 12-24 VDC (Intrinsically Safe)
Black	Supply -	DC GND
Brown	Tare	Short to GND for 5 seconds to tare at zero flow
White	Not Used	Do not connect
Shield	Internally Grounded to Chassis	
Blue	High Alarm Output	Open-collector
Orange	Low Alarm Output	Open-collector
Green	Alarm Common	Emitter for both alarms

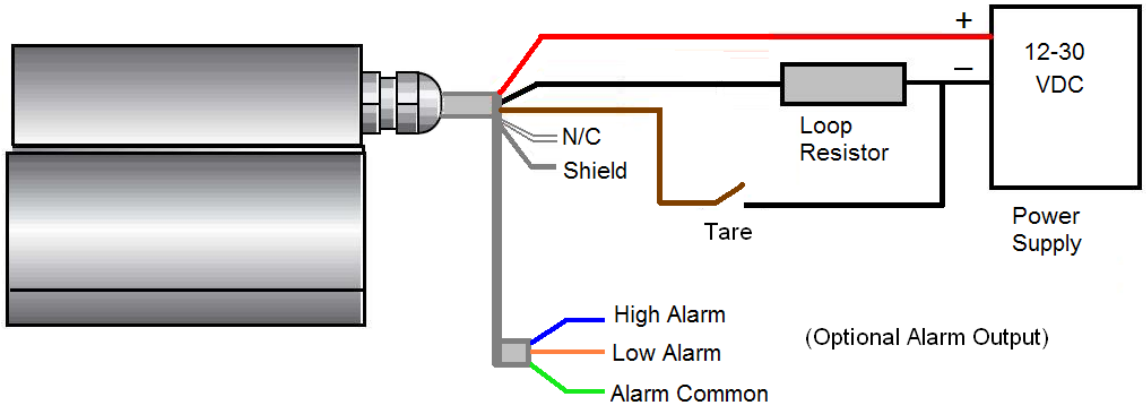


Figure 2. Standard Transmitter Wiring
(DO NOT Use for Intrinsically Safe Applications)

Note: Shield wire (shown as gray) may be connected to an external chassis ground to improve electrical noise immunity. However, care must be taken not to connect this ground to signal ground.

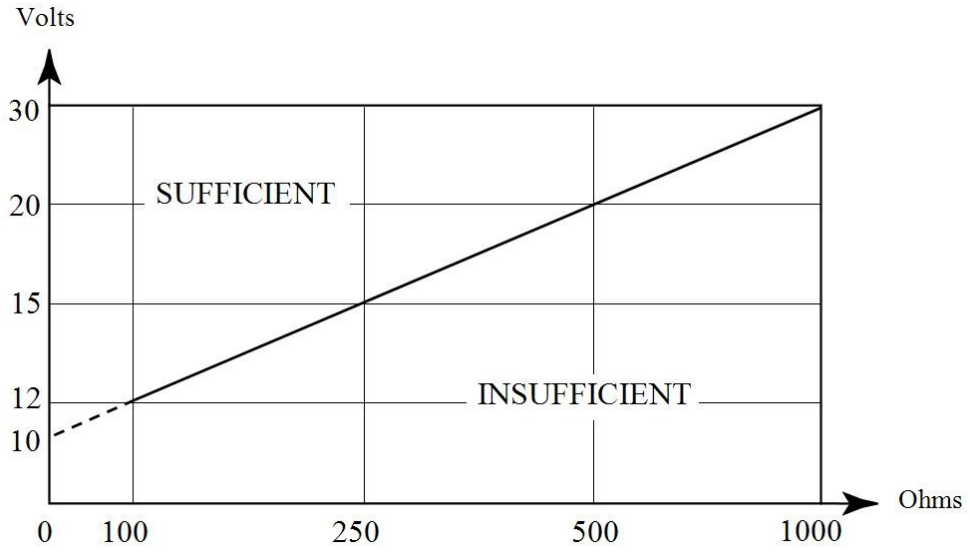


Figure 3. Required Supply Voltage vs. Loop Resistance

Hazardous Environment Wiring

Intrinsically Safe wiring must be installed in accordance with Article 504 of NEC, ANSI NPF 70 and Control Drawing Number 7577, Revision 00 (**Figure 4**, below). The transmitter approval by the Canadian Standards Association for installation in Hazardous environments is based on installation through an Intrinsic Safety Barrier.

The Transmitter when wired through the I.S. Barrier is suitable for use in:

CLASS I GROUPS A, B, C & D
CLASS II GROUPS E, F & G
CLASS III HAZARDOUS LOCATIONS

Earth Ground of the I.S. Barrier must be connected to the earth ground of the AC feeder supply. The resistance between Intrinsically Safe ground terminals and A.C. Earth ground must be less than one Ohm. (UFM suggested I.S. Barrier R.Stahl 9001/01-280-075-10, UFM part number 8140).

The Power Supply voltage is limited to 24 VDC Max. The Power Supply Control Unit must not use or be able to generate more than 250 volts. The Maximum Load that can be put on the system is 250 Ohms.

All repairs on the Flow Transmitter should be accomplished at the factory because any substitution of components may impair Intrinsic Safety.

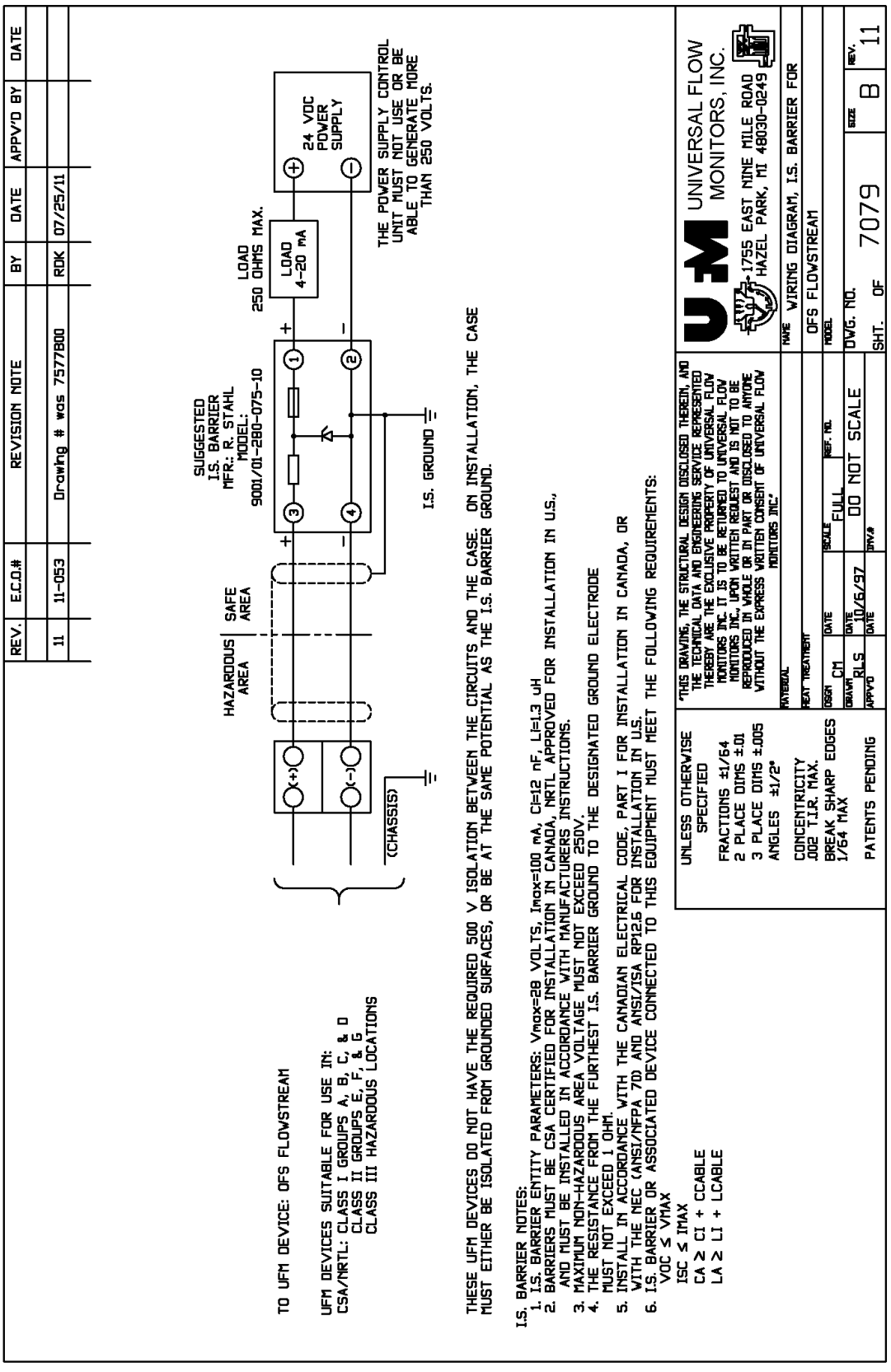

REV. | E.C.O.# | REVISION NOTE | BY | DATE | APPV'D BY | DATE
11 | 11-053 | Drawing # was 7577800 | RDK | 07/25/11
HAZARDOUS AREA
SAFE AREA
SUGGESTED I.S. BARRIER MFR.: R. STAHL MODEL: 9001/01-280-075-10
LOAD 250 OHMS MAX.
LOAD 4-20 mA
24 VDC POWER SUPPLY
THE POWER SUPPLY CONTROL UNIT MUST NOT USE OR BE ABLE TO GENERATE MORE THAN 250 VOLTS.
(+)
(-)
(CHASSIS)
I.S. GROUND
TO UFM DEVICE: OFS FLOWSTREAM
UFM DEVICES SUITABLE FOR USE IN:
CSA/NRTL: CLASS I GROUPS A, B, C, & D
CLASS II GROUPS E, F, & G
CLASS III HAZARDOUS LOCATIONS
THESE UFM DEVICES DO NOT HAVE THE REQUIRED 500 V ISOLATION BETWEEN THE CIRCUITS AND THE CASE. ON INSTALLATION, THE CASE MUST EITHER BE ISOLATED FROM GROUNDED SURFACES, OR BE AT THE SAME POTENTIAL AS THE I.S. BARRIER GROUND.
I.S. BARRIER NOTES:
1. I.S. BARRIER ENTITY PARAMETERS: Vmax=28 VOLTS, Imax=100 mA, Ci=12 nF, Li=1.3 uH
2. BARRIERS MUST BE CSA CERTIFIED FOR INSTALLATION IN CANADA, NRTL APPROVED FOR INSTALLATION IN U.S., AND MUST BE INSTALLED IN ACCORDANCE WITH MANUFACTURERS INSTRUCTIONS.
3. MAXIMUM NON-HAZARDOUS AREA VOLTAGE MUST NOT EXCEED 250V.
4. THE RESISTANCE FROM THE FURTHEST I.S. BARRIER GROUND TO THE DESIGNATED GROUND ELECTRODE MUST NOT EXCEED 1 OHM.
5. INSTALL IN ACCORDANCE WITH THE CANADIAN ELECTRICAL CODE, PART I FOR INSTALLATION IN CANADA, OR WITH THE NEC (ANSI/NFPA 70) AND ANSI/ISA RP12.6 FOR INSTALLATION IN U.S.
6. I.S. BARRIER OR ASSOCIATED DEVICE CONNECTED TO THIS EQUIPMENT MUST MEET THE FOLLOWING REQUIREMENTS:
VOC ≤ VMAX
ISC ≤ IMAX
CA ≥ CI + CCABLE
LA ≥ LI + LCABLE
UNLESS OTHERWISE SPECIFIED
FRACTIONS ±1/64
2 PLACE DIMS ±.01
3 PLACE DIMS ±.005
ANGLES ±1/2°
CONCENTRICITY .002 T.I.R. MAX.
BREAK SHARP EDGES 1/64 MAX
PATENTS PENDING
"THIS DRAWING, THE STRUCTURAL DESIGN DISCLOSED THEREIN, AND THE TECHNICAL DATA AND ENGINEERING SERVICE REPRESENTED THEREBY ARE THE EXCLUSIVE PROPERTY OF UNIVERSAL FLOW MONITORS INC. IT IS TO BE RETURNED TO UNIVERSAL FLOW MONITORS INC. UPON WRITTEN REQUEST AND IS NOT TO BE REPRODUCED IN WHOLE OR IN PART OR DISCLOSED TO ANYONE WITHOUT THE EXPRESS WRITTEN CONSENT OF UNIVERSAL FLOW MONITORS INC"
MATERIAL
HEAT TREATMENT
DSGN CM DATE
DRAWN RLS DATE 10/6/97
APPV'D DATE
SCALE FULL
DWG #
REF. NO.
DO NOT SCALE
UNIVERSAL FLOW MONITORS, INC.
10773-1755 EAST NINE MILE ROAD HAZEL PARK, MI 48030-0249
NAME WIRING DIAGRAM, I.S. BARRIER FOR
OFS FLOWSTREAM
MODEL
DWG. NO. 7079
SIZE B
REV. 11
SHT. OF

Figure 4. Intrinsically Safe Installation

Wiring for Voltage Output Models

Figure 5 shows the wiring for voltage output models. (Optional wiring is also shown for alarm outputs.) For 0-5V models, the supply voltage can be 10-30VDC.

Note: Output voltage range must be specified at the time of ordering. They cannot be interchanged by the user.

Wire Color	Function	
Red	Supply +	15-30VDC
Black	Supply -	DC GND
Brown	Tare	Short to GND for 5 seconds to tare at zero flow
White	Voltage Output	0-5V (or 1-5V) 0-10V (or 2-10V) Bi-directional (0-5V)
Shield	Internally Grounded to Chassis	
Blue	High Alarm Output	Open-collector
Orange	Low Alarm Output	Open-collector
Green	Alarm Common	Emitter for both alarms

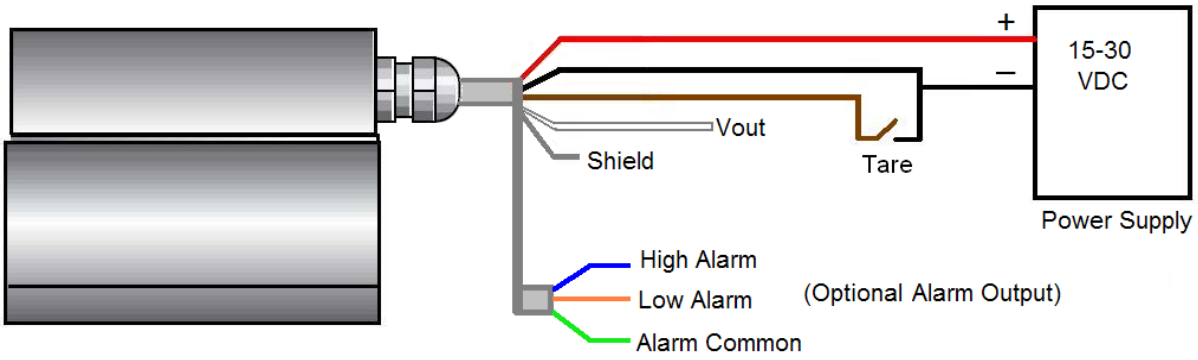


Figure 5. Voltage Output Wiring

Wiring for Frequency or Pulse Output Models

Figure 6 shows the wiring for either frequency output or pulse output models. (Optional wiring is also shown for alarm outputs.)

Note: "Frequency" or "Pulse Output" model must be specified at the time of ordering. They cannot be interchanged by the user.

Wire Color	Function	
Red	Supply +	10-30VDC
Black	Supply -	DC GND
Brown	Tare	Short to GND for 5 seconds to tare at zero flow
White	Frequency Output Or Pulse Output	0-3V signal amplitude
Shield	Internally Grounded to Chassis	
Blue	High Alarm Output	Open-collector
Orange	Low Alarm Output	Open-collector
Green	Alarm Common	Emitter for both alarms

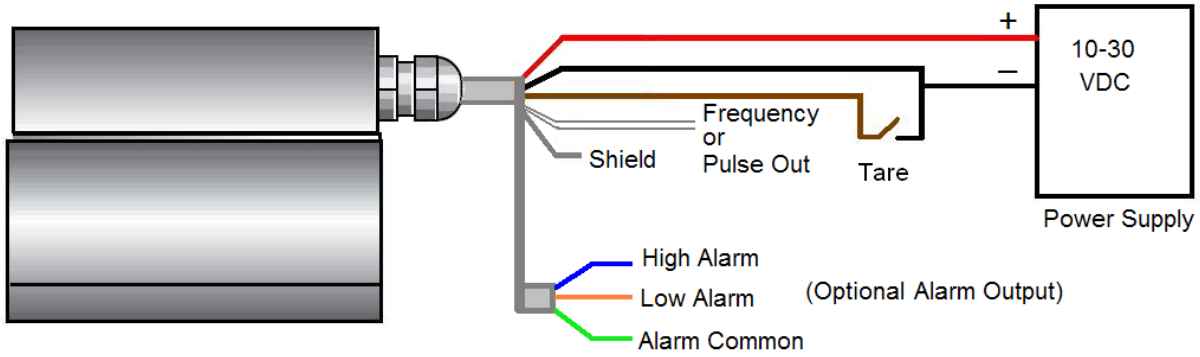
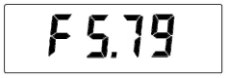


Figure 6. Frequency and Pulse Output Wiring

POWER-UP

At power-up, the following appears on the LCD:

Firmware Revision 5.67 or Higher → 

Electronics Revision →

It takes 2 seconds for these messages to be displayed, during which time the output of the flowmeter is clamped at zero flow. After 2 seconds, the output signal starts indicating actual flow.

LCD READOUT

If the flowmeter is configured for High-Speed (HS) response, the LCD only shows "run". No other parameters can be viewed on the LCD in this mode.

LCD in HS mode:

In Low-Speed (LS) (see Select Response Time) the user can toggle the readout between flow rate, total, pressure, and temperature. When in *Run* mode, use A2 pushbutton to select. The selection is stored in the internal memory, so if power is removed from the flowmeter it remembers the selection next time it is powered up.

Note: The output signal and alarms always indicate "flow rate".

Flow Rate

Available with:	All models in Low-Speed mode
Not Available with:	High-Speed mode

In Run Mode:

1. Press A2 (or press and release a few times) until "rATE" is displayed.
2. Release A2. The flowmeter will display Flow Rate.

Press until "rATE" shown then release

Totalizer

Available with:	Low-Speed Single-Gas Multi-Gas 4-20mA 0-5V (1-5V) 0-10V (2-10V) 0-1000 Hz Battery-operated
Not Available with:	200-1200 Hz Pulse output Bi-directional

Note: In order to view the Totalizer, it must first be "*Started*" in the User Menu (see Totalizer ON/OFF).

1. The first time A2 is pressed, "rATE" is displayed as shown above, to indicate the current selection. Press A2 again until "tot" is displayed.
2. Release A2.

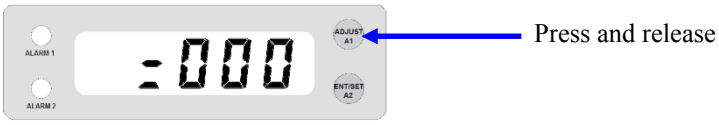
Press until "tot" shown then release

Viewing the Totalizer

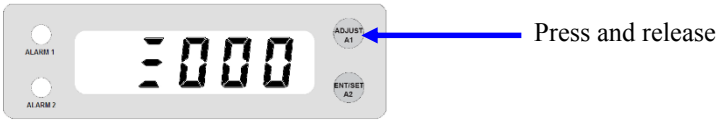
The Totalizer value is displayed in three 3-digit groups (9 digits total) as shown.

This is the low-order 3 digits (000 through 999), as indicated by the one horizontal bar on the left of the LCD. The low-order digits may or may not include a decimal point. This depends on the displayed units in rate mode. Maximum Totalizer reading is therefore scaled according to the decimal point position and is between 999,999.999 and 999,999,999.

3. Use A1 to toggle between the different Totalizer digit groups.



This is the middle-order 3 digits (1,000 through 999,000), as indicated by the two horizontal bars on the left of the LCD.



This is the high-order 3 digits (1,000,000 through 999,000,000), as indicated by the three horizontal bars on the left of the LCD.

Note 1: Output signal is always indicative of Flow Rate regardless of what the LCD is displaying.

Note 2: The Totalizer is updated every 100 msec. Therefore, flow variations that happen faster that 100 msec cannot be accumulated accurately. In order to meet the specified accuracy of the Totalizer, flow must be steady within each 100 msec sampling window (preferably even longer, to ensure each sample is captured accurately).

Note 3: Rate Alarms are active in the background and their corresponding LED lights up when alarm condition is encountered. Response time for the Rate Alarms is 50 msec, since the flowmeter is running in Low-Speed mode.

Note 4: The Totalizer reading is saved once every 5 minutes in the non-volatile memory. This means that the maximum error due to power loss can be up to the last 5 minutes of operation. This is also the response time for the Rate Alarms. The reading can be saved by the user at any time (e.g., the end of a batch) by pressing A2 ("tot" is displayed), followed by pressing A1 (while still holding A2).

When the Totalizer readout exceeds 9 digits (inclusive of the decimal places), the display shows two lower vertical bars on the left side to indicate overflow. The leftmost display segments will look like the following patterns:

Low order digits in overflow:

Middle order digits in overflow:

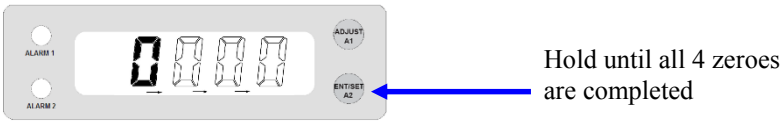
High order digits in overflow:

The count shown on the display remains accurate until a second overflow occurs (2,000,000,000 is
reached). In this case the vertical bar does not reflect how many times overflow has occurred.

Resetting the Totalizer

- Press A2 until “tot” is displayed. (You must be in “Totalizer” mode first.)
- Hold A2 for 5 seconds. Four rotating zeroes start to appear.
- Continue holding A2 until all zeros are completed and “tot” is displayed again. Then release A2.

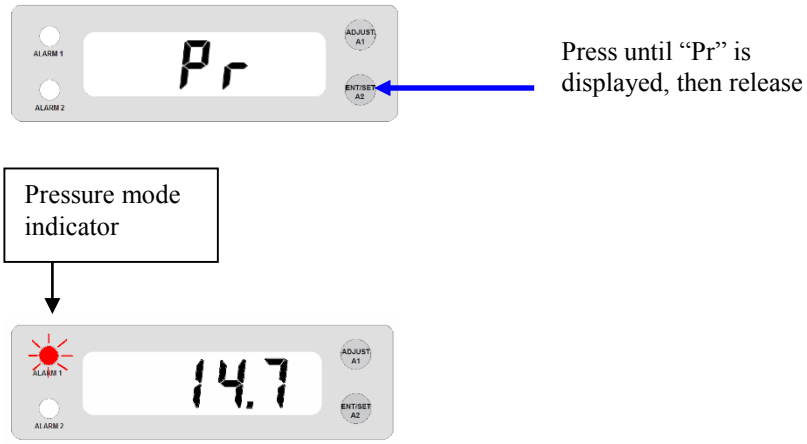
Note: If A2 is released before the rotating zeroes are completed, the resetting of the Totalizer is ignored.



Pressure

Available with:	All models in Low-Speed mode
Not Available with:	High-Speed mode

1. Press A2 until “Pr” is displayed, then release A2.



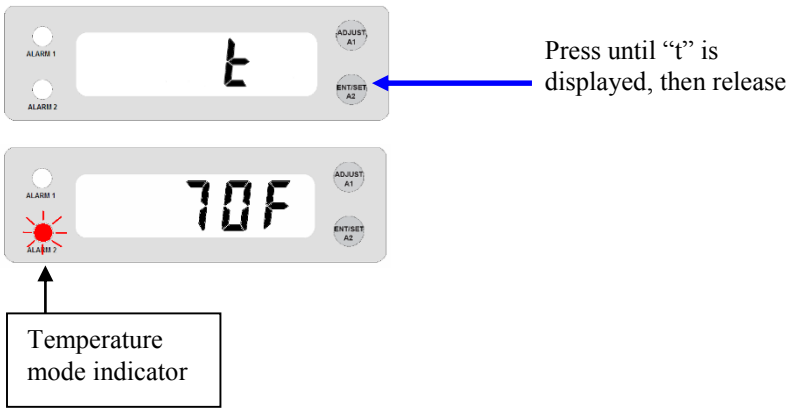
Note 1: Pressure is displayed in PSIA. There is no output signal for pressure.

Note 2: Alarm 1 LED flashes to indicate that the LCD readout corresponds to line pressure and not flow.

Temperature

Available with:	All models in Low-Speed mode
Not Available with:	High-Speed mode

1. Press A2 until “t” is displayed, then release A2.



Note 1: Temperature is displayed in degrees Fahrenheit. There is no output signal for temperature.

Note 2: Alarm 2 LED flashes to indicate that the LCD readout corresponds to gas temperature, as well as “F” which is shown after the temperature reading.

USER MENU

The following features and options can be selected, viewed and changed by the user.

- Response Time – Select between high-speed (5 msec) and low-speed (up to 50 msec)
- Sample Delay – Sampling delay from 0-9 msec
- Signal Averaging – Array size for the moving average (1-16 samples)
- High Flow Alarm – From 0–100% of full-scale
- Low Flow Alarm – From 0-100% of full-scale
- Tare – Correct small zero-shift errors
- Span – Scale the output signal from 25-120%
- Gas – Select one of 8 common gases
- Totalizer – Start/Stop the Totalizer
- Pulse Output – Select pulse rate and width
- Battery – Monitor battery voltage

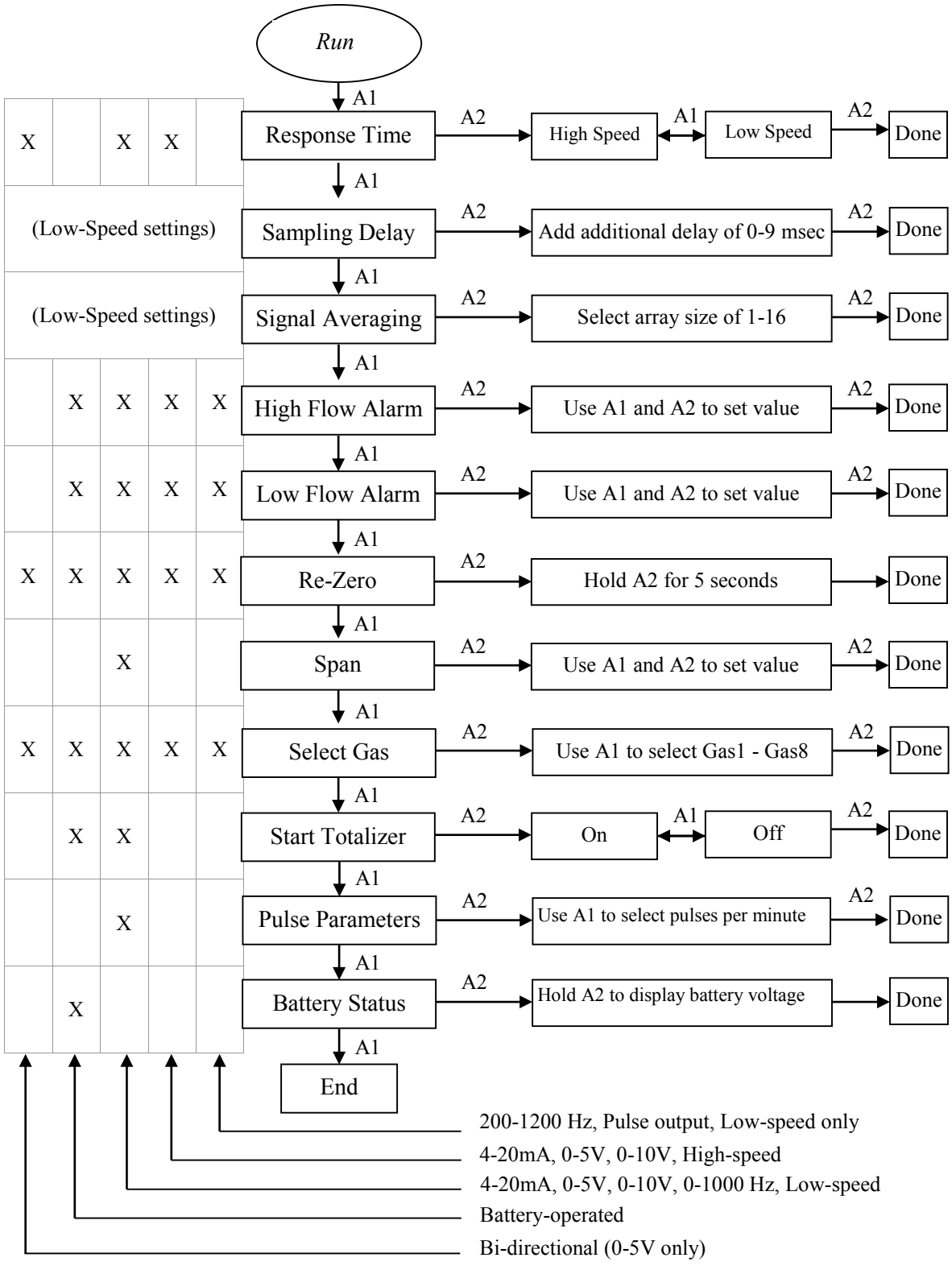
General Notes:

- These features apply to flowmeters with a built-in LCD display. For units without the display consult the factory to check what options can be preset at the factory.

- Two pushbuttons are provided for user interface. A1 (ADJUST) pushbutton is used to scroll through the user menu and its options, and A2 (ENT/SET) is used to select the feature of interest.

- When the flowmeter is in high-speed (HS) mode, the LCD displays "run" and no other parameters can be viewed. This is for achieving the fastest possible response time (5 msec) and minimizing the CPU overhead.

OFS Menu Structure and Feature Compatibility



Select Response Time

Available with:	High-Speed Low-Speed Single-Gas Multi-Gas 4-20mA 0-5V (1-5V) 0-10V (2-10V) Bi-directional
Not Available with:	0-1000 Hz 200-1200 Hz Pulse output Battery-operated

1. Press A1 until “rESP” is displayed, then release A1.
2. Press A2. Either “HS” (high-speed) or “LS” is displayed, showing the current setting.
3. Press A1 to toggle between the two options.
4. Press A2 to select the desired selection.
5. The LCD will show “End” and the unit returns to normal operation.

- If “HS” is selected, the LCD will only show “run”. The analog output is updated as quickly as a single flow sample is acquired, which is about every 5 milliseconds.
- If “LS” is selected, the LCD will show the flow rate, and the flow signal is averaged to provide a smoother output. The step response for “low-speed” output is determined by the sample delay (if any) and the signal averaging array size. These values are user selectable (see the next section).

Sampling Delay

Available with:	Low-Speed Single-Gas Multi-Gas 4-20mA 0-5V (1-5V) 0-10V (2-10V) Bi-directional
Not Available with:	0-1000 Hz 200-1200 Hz Pulse output Battery-operated

1. Press A1 until “dELY” is displayed, then release A1.
2. Press A2. The current setting will be shown. This is a value between 0-9, in milliseconds.
3. Press A1 to toggle between the values.
4. Press A2 to select the desired selection.
5. The LCD will show “End” and the unit returns to normal operation.

- Each flow sample takes about every 5 milliseconds to complete. This is an additional delay that is inserted after the flow sample to slow down the flowmeter response time. In some applications where the flowmeter is used in a feedback loop to regulate flow, if the response time is too fast the system starts oscillating.
- The delay setting is only used when the meter operates in “LS” (Low-Speed) mode. It is ignored in “HS” (High-Speed) mode.

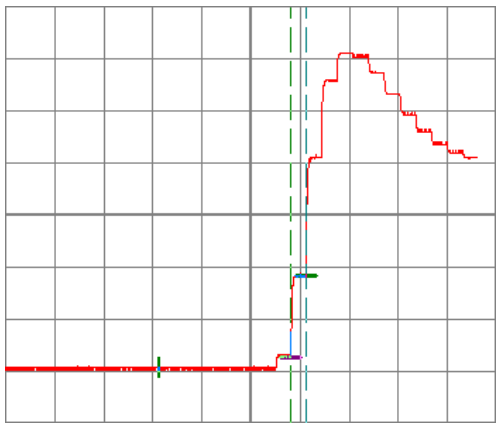
Signal Averaging

Available with:	Low-Speed Single-Gas Multi-Gas 4-20mA 0-5V (1-5V) 0-10V (2-10V) Bi-directional
Not Available with:	0-1000 Hz 200-1200 Hz Pulse output Battery-operated

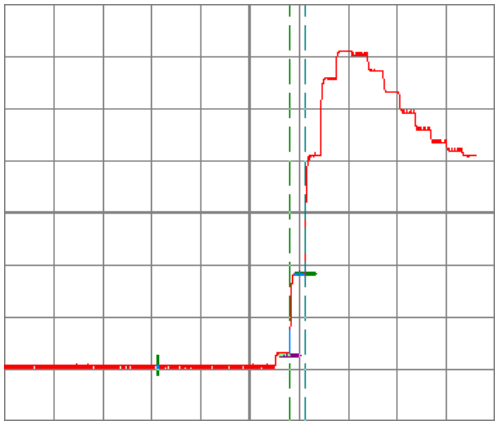
1. Press A1 until "AvG" is displayed, then release A1.
2. Press A2. The current setting will be shown. This is a value between 1-16, and indicates how many flow samples are averaged (moving average window size) to calculate the output.
3. Press A1 to toggle between the values.
4. Press A2 to select the desired selection.
5. The LCD will show "End" and the unit returns to normal operation.

- Each flow sample takes about every 5 milliseconds to complete. The "AvG" value is the size of the moving average array, allowing for 1 to 16 samples to be averaged when the output is calculated. This is used to slow down the flowmeter response time, and provide a smoother output. In some applications where the flowmeter is used in a feedback loop to regulate flow, if the response time is too fast the system starts oscillating.
- The delay setting is only used when the meter operates in "LS" (Low-Speed) mode. It is ignored in "HS" (High-Speed) mode.

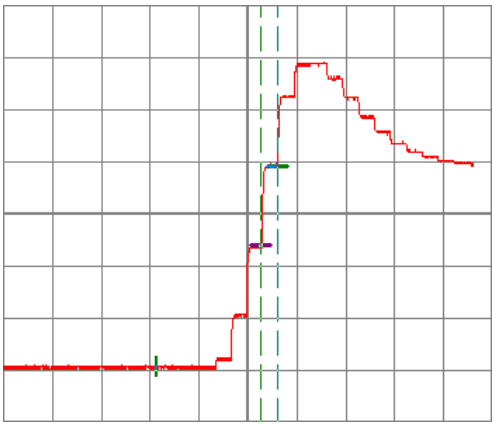
Step Response Examples:



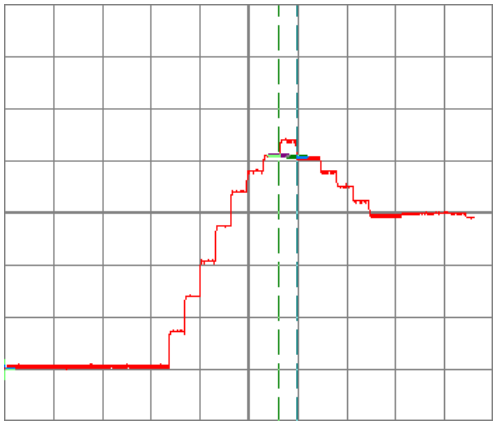
Response = HS
Delay = N/A
AVG = N/A
10 ms/div



Response = LS
Delay = 0
AVG = 1
10 ms/div



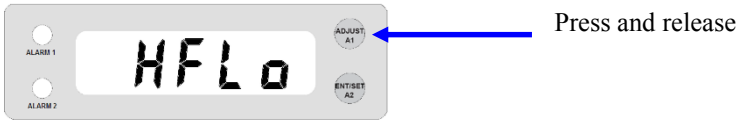
Response = LS
Delay = 0
AVG = 4
10 ms/div



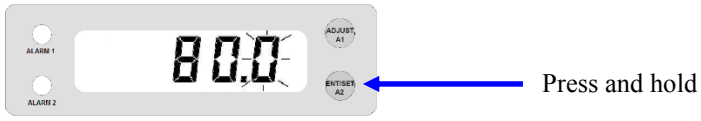
Response = LS
Delay = 9
AVG = 8
50 ms/div

Set High Flow Alarm

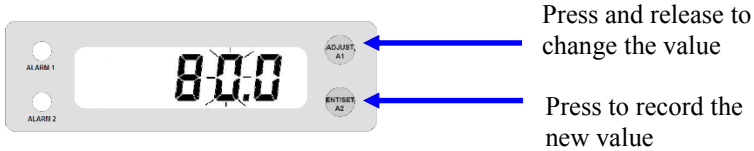
Available with:	High-Speed Low-Speed Single-Gas Multi-Gas 4-20mA 0-5V (1-5V) 0-10V (2-10V) 0-1000 Hz 200-1200 Hz Pulse output Battery-operated
Not Available with:	Bi-directional



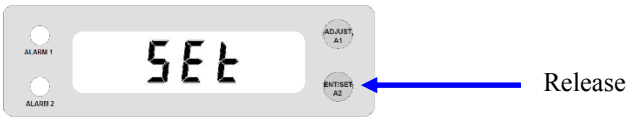
1. Press A1 until "HFLo" is displayed, then release A1.
2. Press A2 and hold until the setpoint is displayed on the LCD (in this example, high flow alarm is set at 80.0). Then release A2. The first digit starts blinking.



3. Use A1 to change the blinking digit. The setpoint is changed one digit at a time. A1 increments each individual digit (9 rolls over back to 0), while A2 is used for recording the new digit value and selecting the next digit.
4. Use A2 to record the new value and select the second digit.



5. After the last digit is set, continue holding A2 until "SEt" is displayed. If you want to change the first digit again, do not hold A2. Momentarily press and release A2 and the first digit starts blinking again.
6. When finished recording the new setpoint ("SEt" is displayed), release A2.



Note 1: Valid setpoint range is 0-100% of full-scale flow. If the alarm value is set higher than full-scale, it is clamped at full-scale upon exiting this menu.

Note 2: To disable the alarm, set its value to zero.

Note 3: The red ALARM 1 LED comes on when flow exceeds this setpoint. This LED is in series with the drive circuit for the high-alarm open-collector output, meaning that the output transistor is active whenever this LED is on. Some models do not have any external wiring that connects to the alarm transistor (see Model Codes).

In this example, the high alarm had been set for 80.0; therefore, the red LED was activated when flow reached 80.1. The LED turns off when flow < setpoint – hysteresis. Hysteresis is 5% of full-scale.

Set Low Flow Alarm

Available with:	High-Speed Low-Speed Single-Gas Multi-Gas 4-20mA 0-5V (1-5V) 0-10V (2-10V) 0-1000 Hz 200-1200 Hz Pulse output
Not Available with:	Battery-operated Bi-directional

1. Press A1 (or press and release a few times) until "LFLo" is displayed, then release A1.

Use the same method as explained above ("Set High Flow Alarm") to set the low flow alarm as follows:

2. Press A2 and hold until the setpoint is displayed on the LCD. Then release A2. The first digit starts blinking.
3. Use A1 to change the blinking digit (9 rolls over back to 0).
4. Use A2 to select different digits.
5. After the last digit, momentarily press and release A2 to go back to the first digit again, or continue holding A2 until "SEt" is displayed. Then release A2.

Note 1: Valid setpoint range is 0-100% of full-scale flow. If the alarm value is set higher than full-scale, it is clamped at full-scale upon exiting this menu.

Note 2: To disable the alarm, set its value to zero.

Note 3: The red ALARM 2 LED comes on when flow drops below this setpoint. This LED is in series with the drive circuit for the low-alarm open-collector output, meaning that the output transistor is active whenever this LED is on. Some models do not have any external wiring that connects to the alarm transistor (see Model Codes). The LED turns off when flow > setpoint + hysteresis. Hysteresis is 5% of full-scale.

Tare (Re-Zero) the Flowmeter

Available with:	ALL MODELS

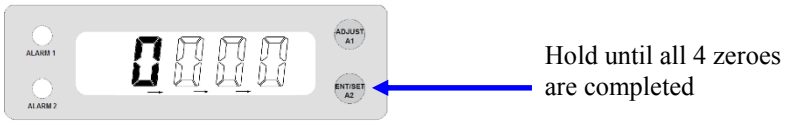
Important Notice: Because of the excellent sensitivity of these flowmeters, small readings may actually indicate leaks in the system and should not be zeroed out. Ensure that there is no flow through the device when attempting to tare the output.

The flowmeter can be tared in two ways:

- by using the pushbuttons;
- by grounding the Tare wire (the brown wire).

USING pushbuttons:

1. Press and release A1 until The LCD will show "Tare":
2. Press and hold A2. The display will show "0000" after 5 seconds. This is shown as 4 rotating zeros on the LCD:



"SEt" is then displayed.

Note 1: If A2 is released before all 4 zeros are completed, the tare request will be ignored.

Note 2: There is a limit within which the flowmeter can be tared. This limit is about 8% of full-scale. The actual shift in zero reading is typically far less drastic (in the order of 1-2%). If the flowmeter indicates a reading higher than 8% of full-scale, it cannot be tared because this may indicate that either there is flow through the device or an internal component has physically failed. If you attempt to tare under this condition, the flowmeter displays "EEEE" on the LCD instead of "SEt". This is a visual indicator that the tare process encountered an error. This error condition applies to both pushbutton and external wire taring.

Note 3: There is an internal memory check that monitors for proper recording of the zero value. This includes a series of redundant memory locations that serve as backup. If an error occurs (i.e., a recorded value does not match what was written to the memory), the flowmeter ignores the new setting and reverts back to factory calibration. Such an error is displayed as "E1E2" following a tare attempt, and also at power-up. If you encounter this error message, please contact the factory for further assistance.

USING the external Tare wire:

Refer to **Figure 2, Figure 5 or Figure 6**, showing the proper connection between the external Tare wire and ground. Short this wire to ground for a minimum of 5 seconds. "Tare" will be displayed as soon as the wire is grounded and remains displayed until the internal tare is successfully completed, upon which time "SEt" will be displayed. If the ground connection is removed from the Tare wire in less than 5 seconds, the tare request is ignored and "SEt" will NOT be displayed. This time delay feature is implemented to prevent accidental grounding of the external wire. Notes 1 and 2 above also apply to external taring.

Note 4: When taring is taking place (either through the pushbuttons or the external wire), the flowmeter output signal is "frozen". The level at which the output is frozen depends on what the most recent flow reading was, prior to activating the tare input. If you encounter a problem where the flowmeter output does not respond to changes in flow, check for problems in the Tare wiring (shorts to ground, etc.), or a malfunctioning pushbutton (A1).

Note 5: When not in use, the Tare wire **MUST** either be left floating (open-circuit), or taken high to the power supply voltage via a 10K pull-up resistor. When taring is not needed, **DO NOT** hold the Tare line at voltages below the supply voltage! This may leave the tare circuitry partially activated, thus resulting in "frozen" or erroneous outputs.

Note 6: The external Tare wire is designed to be a momentary signal of 5 to10 seconds in duration. Grounding this signal for long periods of time (over many minutes) may cause an internal **damage** to the tare circuitry when the supply voltage is above 18V.

Scaling the Output Span

Available with:	Low-Speed Single-Gas Multi-Gas 4-20mA 0-5V (1-5V) 0-10V (2-10V)
Not Available with:	High-Speed 0-1000 Hz 200-1200 Hz Pulse Output Battery-Operated Bi-directional

This feature is for scaling the analog output to a value other than the factory calibration. For example, for a 100 SLPM flowmeter with 4-20mA output, the output can be spanned to 20mA at 75 SLPM.
The acceptable range is 25-120% of full-scale. The formula for the span factor is:

Full-Scale x Factor = Full Span

Example: 100 SLPM x 75% = 20mA
75 SLPM = 20mA
Values above 100% mean that the output signal is attenuated. This may be desirable in cases where the flowmeter is over-ranged up to 20% of full-scale. When the span factor is changed from its factory setting, there will be some loss of linearity, accuracy, and output resolution. Please consult the factory for details.

1. Press and release A1 until “SPAn” is displayed.
2. Release A1.
3. Use A1 and A2 (as shown under “Set High Flow Alarm”) to type in a value that is between 25.0 and 120.0. This is the “Factor” percentage as shown in the above formula.
4. When the desired factor is entered, press and hold A2 until “SEt” is displayed. Then release A2.

Note 1: The LCD always displays true flow in the factory-calibrated units. Spanning the output does not affect the LCD readout.
Note 2: If the Span Factor is set to a value that is outside the 25.0 – 120.0 range, it is changed back to 100.0 upon exiting this menu.

Selecting the Gas

Available with:	High-Speed Low-Speed Single-Gas Multi-Gas 4-20mA 0-5V (1-5V) 0-10V (2-10V) 0-1000 Hz 200-1200 Hz Pulse output Battery-operated Bi-directional
Not Available with:	Single-Gas

1. Press and release A1 until "GAS" is displayed. Then release A1.
2. Press A2, the current selection will be displayed as shown

3. Use A1 to change the gas number according to the following list:

Number	Gas	Additional Accuracy Degradation
1	Air	0%
2	Argon	0.2%
3	CO2	1%
4	Helium	1%
5	Hydrogen	1%
6	Methane	1%
7	Nitrogen	0.2%
8	Oxygen	1%

Note: There is additional degradation of accuracy when gases other than Air are selected. This is shown in the column next to each gas and must be added to the standard accuracy of the unit, as shown under Electrical Specifications.

Totalizer ON/OFF

Available with:	Low-Speed Single-Gas Multi-Gas 4-20mA 0-5V (1-5V) 0-10V (2-10V) 0-1000 Hz Battery-operated
Not Available with:	High-Speed 200-1200 Hz Pulse output Bi-directional

1. Press and release A1 until “tot” is displayed.
2. Release A1.
3. Press A2. If the Totalizer is running the LCD will show “on”.
4. If you need to stop the Totalizer, press and release A1. This feature may be useful to prevent the Totalizer from counting during setting up a batch process.

5. If the LCD shows “off”, this means the Totalizer is not running, and it cannot be accessed in *RUN* mode (see Totalizer). In this case, the current Totalizer count is preserved and will not change when there is flow through the unit.

6. To *START* the Totalizer press and release A1, until the LCD shows “on”. Then press and release A2 to record the setting.
7. Likewise, to *STOP* the Totalizer, press and release A1 until “off” is displayed. Then press and release A2.

Pulse Output Setting

Available with:	Low-Speed Single-Gas Multi-Gas Pulse Output
Not Available with:	High-Speed 200-1200 Hz 4-20mA 0-5V (1-5V) 0-10V (2-10V) 0-100 Hz Battery-operated Bi-directional

The pulse output rate is typically 5000 pulse per minute for all models. Pulse width is 2 msec for all models.

To convert the above numbers to "pulses per standard liters," "pulses per standard cubic centimeters" or "pulse per standard cubic feet" divide the pulse count by the full-scale value of the particular flowmeter.

Example 1: The output for a 100 SLPM flowmeter is 5000/100 = 50 pulses per standard liters.

Example 2: The output for a 500 SCFH flowmeter is 300,000/500 = 600 pulses per standard cubic feet. (5,000 x 60 minutes = 300,000 pulses per hour)

1. To set the pulse rate, press and release A1 until "PULS" is displayed.
2. Press A2, the current pulse count will be displayed. Then release A2.
3. Press and release A1. The displayed choices are 5000, 2500, and 1250.
4. When the desired value is selected, press A2 to record it.
5. "SEt" is displayed and the unit returns to *RUN* mode with the new setting.

Checking Battery Voltage

Available with:	Battery-operated
Not Available with:	All Other Models

1. Press and release A1 until “bAtt” is displayed.
2. Press and hold A2 to read the battery voltage.
3. Release A2 when done.

This feature is intended for checking how much battery life is left. Typically, when a 9V alkaline battery voltage drops to 7.5V, it should be replaced.

Note 1: The microprocessor continuously monitors the battery voltage during operation. When the voltage drops to 7.5V during *RUN* mode, the two red LEDs start blinking. This means you have a few more hours of reliable operation left.

3-5 hours of battery life left:

In this example, the LCD shows zero flow. It will be indicating actual flow when in use.

Note 2: When the battery voltage drops to 7.1V, both red LEDs stay on (solid) to indicate that the internal circuitry no longer has a stable reference voltage to operate. In this case, the flowmeter will start to show erroneous readings. You MUST replace the battery at this point.

Replace battery:

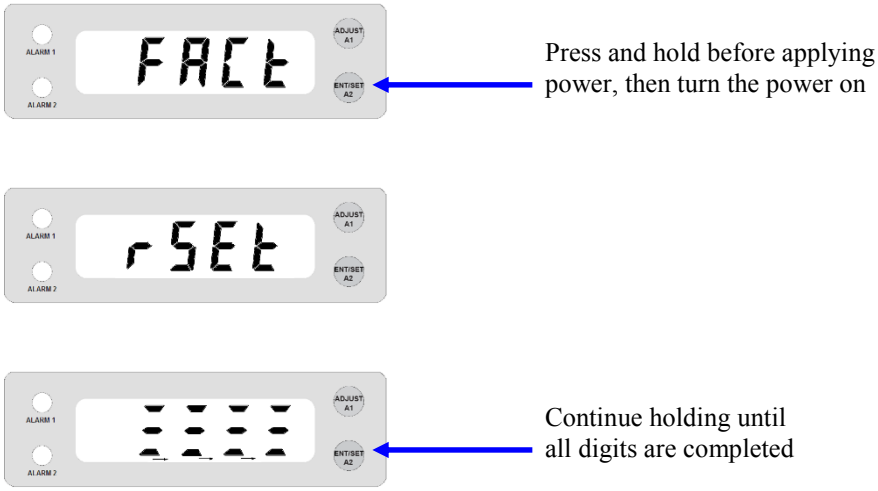
SPECIAL FEATURES

Factory Reset

This feature is provided to override all user-configurable parameters, and replacing them with the original factory settings. It is a useful tool if the user is unsure how he/she has programmed some of the parameters.

To enter the Factory Reset mode:

1. Remove power from the unit.
2. Press A2 and hold.
3. Turn the power back on. Continue holding A2 until "FACt rSEt" is displayed, followed by 4 sets of horizontal bars. This will take approximately 10 seconds. Then release A2.
4. The unit will then reset itself and start in *RUN* mode



Low Supply Voltage Indicator

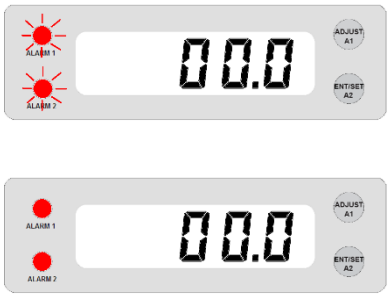
If the supply voltage drops below acceptable levels, the two Alarm LEDs will either flash or turn on (solid). If the alarm outputs are wired, the signal will track the LED states to indicate that the operation of the flowmeter is unreliable.

This is a useful tool in situations when multiple instruments are connected to one power supply, thus loading the supply voltage down. Another example is when the loop resistance for a 4-20mA flow transmitter is too high, leaving insufficient voltage for the flowmeter to operate properly (see Figure 3).

Note 1: This feature is only available when the flowmeter response time is configured for Low-Speed (LS).

Note 2: This feature is not available with 4-20 mA output option.

Low Supply Voltage:



In this example, the LCD shows zero flow. It will be indicating actual flow when in use.

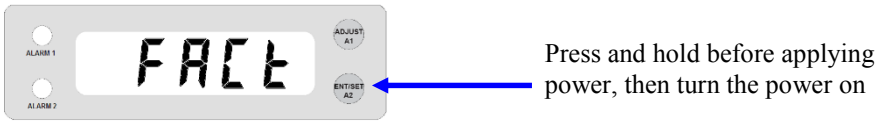
Diagnostic Mode

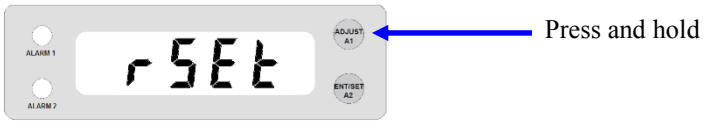
This feature is provided to observe the state of the internal sensors. It is strictly a passive troubleshooting tool. THERE ARE NO USER-SERVICEABLE PARTS INSIDE THE FLOWMETER. If any parts of the flowmeter are removed or unscrewed, the warranty becomes void and UFM assumes no responsibility for the proper operation and/or safety of the unit.

If the operation of the flowmeter seems unstable or incorrect, contact the factory for a step-by-step diagnostic. You will be asked to enter the Diagnostic mode as show below, and report the value for each sensor. This would provide sufficient information for determining if an internal component has failed.

To enter Diagnostic mode:

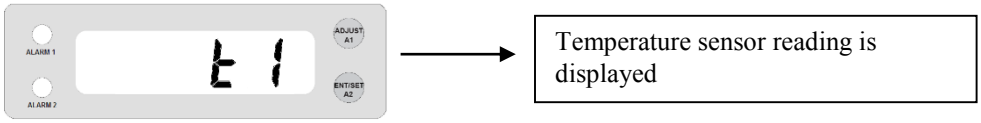
1. Enter "rAtE" mode (see Flow Rate).
2. Remove power from the unit.
3. Press A2 and hold.
4. Turn the power back on. Continue holding A2 until "FACt" is displayed.
5. Release A2 and immediately press A1 before the horizontal bars appear.



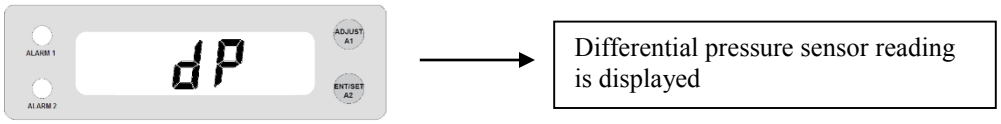


6. When "dIAG" is displayed, release A1.

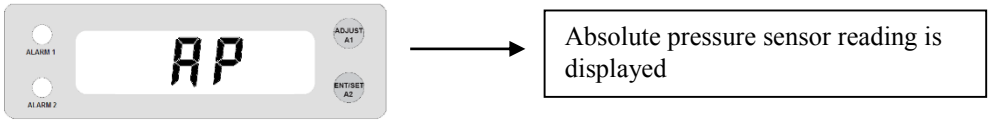
7. The LCD will show "t1" for one second, followed by a 3- or 4-digit reading.
8. Observe this reading for about 10 seconds to make sure it is stable. Then record the low and high values encountered during the 10 seconds.



9. Press A2 until “dP” is displayed, then release A2.
10. The LCD will show a 3- or 4-digit reading.
11. Observe this reading for about 10 seconds to make sure it is stable. Then record the low and high values encountered during the 10 seconds.



12. Press A2 until “AP” is displayed, then release A2.
13. The LCD will show a 3- or 4-digit reading.
14. Observe this reading for about 10 seconds to make sure it is stable. Then record the low and high values encountered during the 10 seconds.



15. Press A2 to reset the unit and return to *RUN* mode or, alternately, remove and re-apply power to the unit.

HOW TO ORDER A SINGLE-GAS FLOWMETER

Select the appropriate symbols to build a model code:

Example: OFS - E F - 3 A - 200 SLPM - T - X 1B - D10

SERIES = OFS

MATERIAL FOR METER BODY

Anodized Aluminum	= E
316 Stainless Steel	= I

SEALS

Viton®	= F
Buna N	= B

THREAD TYPE FOR THREADED PORT

N	= NPT
T	= SAE
B	= BSPT
P	= BSPP

GAS

Air	Argon	CO2	Helium	Hydrogen	Methane	Oxygen	Nitrogen
= A	= R	= CO2	= HE	= H	= M	= O2	= N

PIPE SIZE in Inches	MAXIMUM FLOW IN SLPM							
1/4 = 2	128	107	64	116	256	107	116	128
3/8 = 3	* 228	190	114	208	457	190	208	228
1/2 = 4	548	457	274	498	1096	457	498	548
3/4 = 6	1000	833	500	909	1999	833	909	1000

	MAXIMUM FLOW IN SCFH							
1/4 = 2	280	233	140	255	560	233	255	280
3/8 = 3	500	417	250	455	1000	417	455	500
1/2 = 4	1200	1000	600	1091	2400	1000	1091	1200
3/4 = 6	2188	1824	1094	1989	4377	1824	1989	2188

NOTE: Lowest maximum flow rates are 50 SCCM and 1 SCFH respectively.

** NOTE: The flows selected in each size must be less than or equal to the maximum.*

OUTPUT

Digital Visual Display with Output

X 1A	= 4-20mA
X 1B	= 4-20mA with 2 alarms
X 2A	= 4-20mA Intrinsically Safe
X 4A	= 0-5 VDC
X 4B	= 0-5 VDC with 2 alarms
X 5A	= 0-10 VDC
X 5B	= 0-10 VDC with 2 alarms
X 12A	= 1-5 VDC
X 12B	= 1-5 VDC with 2 alarms
X 14A	= 2-10 VDC
X 14B	= 2-10 VDC with 2 alarms
X 19A	= 0-1000 HZ
X 20A	= 200-1200 HZ
X 22A	= pulse out (rate varies with size)
X 30A	= 0-5 VDC (bi-directional flow)
X 40A	= visual readout only (battery powered)

No Visual Display with Output

Z 1A	= 4-20mA
Z 2A	= 4-20mA Intrinsically Safe
Z 4A	= 0-5 VDC
Z 5A	= 0-10 VDC
Z 12A	= 1-5 VDC
Z 14A	= 2-10 VDC
Z 19A	= 0-1000 HZ
Z 20A	= 200-1200 HZ
Z 22A	= pulse out (rate varies with size)
Z 30A	= 0-5 VDC (bi-directional flow)

SPECIAL OPTIONS

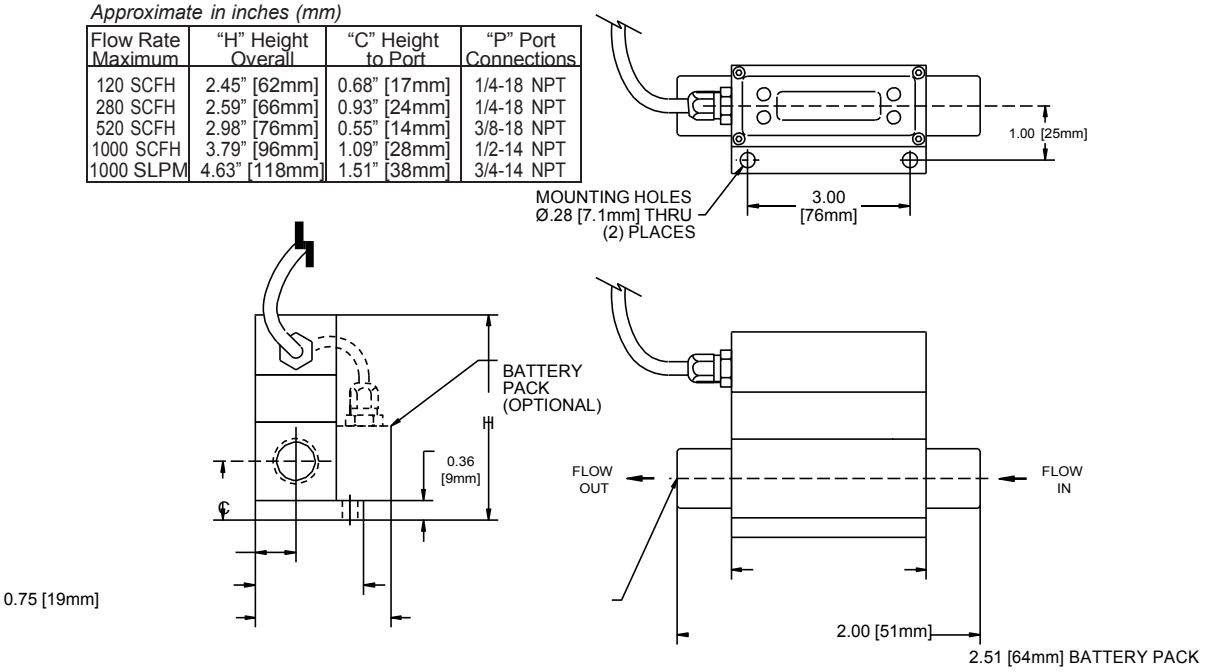
CLEAN FOR OXYGEN SERVICE	= C1
10 FOOT CABLE	= D10
VACUUM USE (7.35 to 14.7PSIA)	= ZVAC

NOTE: Also good for use at normal pressures

DIMENSIONS OF OFS SERIES

Approximate in inches (mm)

Flow Rate Maximum	"H" Height Overall	"C" Height to Port	"P" Port Connections
120 SCFH	2.45" [62mm]	0.68" [17mm]	1/4-18 NPT
280 SCFH	2.59" [66mm]	0.93" [24mm]	1/4-18 NPT
520 SCFH	2.98" [76mm]	0.55" [14mm]	3/8-18 NPT
1000 SCFH	3.79" [96mm]	1.09" [28mm]	1/2-14 NPT
1000 SLPM	4.63" [118mm]	1.51" [38mm]	3/4-14 NPT



NOTICE

RETURN MATERIAL AUTHORIZATION

Please read the following UFM policy information carefully. By following the guidelines outlined below you will assist in providing a timely evaluation and response regarding the status of your flowmeter. UFM evaluates all AUTHORIZED RETURNED MATERIALS in a timely manner and will promptly provide notification regarding the status of the related materials and/or a written quotation indicating the total charges and description of the necessary repairs.

1. All returns must have a RMA form completed by the customer.
2. Any meter returned that was previously in service must have the OSHA requirements completed and a MSDS included where applicable.
3. An RMA number will only be issued when UFM has received a copy of the completed RMA form and any applicable MSDS.
4. A "Return Goods" shipping label (located in the back of the Instruction Manual) must be used for returning materials to UFM.
5. Returned goods must be shipped prepaid or they will be rejected.

REPAIRABLE MATERIAL

Written or verbal authorization to proceed with the repair under an assigned Purchase Order must be received within 30 days of repair quotation. If the unit(s) is repaired, the $90.00 evaluation charge will be applied to the quoted repair costs. If no repairs are authorized within this 30-day period, the customer will be billed $90.00 plus shipping charges and the materials will be returned to the customer.

NON-REPAIRABLE MATERIAL

If materials are found non-repairable, a written notice that the material is non-repairable will be provided to the customer by UFM. If no disposition to scrap or return the material is received from the customer within 30 days, non-repairable material will be scrapped and the customer will be billed the $90.00 evaluation charge. If a UFM replacement unit is purchased within 30 days of non-repairable condition notice, the $90.00 evaluation fee will be waived. The return of non-repairable materials may be ordered by a customer Purchase Order; shipping and handling charges will be assumed by customer.

RETURN FOR RESTOCK

All goods returned for restock adjustment **must** be:
A. New and unused.
B. Returned to the factory within ONE YEAR of date of original shipment.
C. Returned through the distributor where the goods were originally purchased.
D. Returned material will be subject to an evaluation charge of $90.00.

The customer will be advised of the restocking adjustment for all restockable goods. Upon customer's acceptance of the restocking adjustment, the $90.00 evaluation fee will be waived and UFM will issue a credit to the customer. The customer will be advised of any **non-restockable** goods and will be charged the $90.00 evaluation fee plus any shipping charges if goods are returned to the customer.

If no disposition is received by UFM within 30 days, the goods will be scrapped and the $90.00 evaluation fee will be billed.

WARRANTY RETURNS

Warranty returns must be shipped prepaid to UFM. UFM will review the goods and advise the customer of the evaluation and validity of the warranty claim. Valid warranty claims will be repaired or replaced at no charge. No evaluation fee will be charged for repairs made under warranty. Return shipping costs will be prepaid by UFM. Should UFM determine returned material not to be defective under the provisions of UFM's standard warranty, the customer will be advised of needed repairs and associated costs. All materials returned for warranty repair that are determined not to have a valid warranty claim will be subject to the **"Repairable Material"** policy outlined above.

WARRANTY INFORMATION

1) ACCEPTANCE AND INTEGRATION CLAUSE: This Sales Order Acknowledgment and the sales order information that Universal Flow Monitors, Inc. ("Universal") attaches to or associates with it (herein "Acknowledgment"), constitutes an acceptance by Universal of an offer by the buyer upon the conditions and terms and at the prices stated in this Acknowledgment. The Acknowledgment contains the entire understanding of Universal and the buyer regarding the subject matter of said Acknowledgment. This Acknowledgment may only be modified by a written agreement signed by the party against whom enforcement is sought.

2) WAIVER: Waiver by Universal of any default(s) by the buyer shall not constitute waiver by Universal of any of the conditions of the agreement between Universal and the buyer as set forth hereunder with respect to any further or subsequent default by the buyer.

3) FORCE MAJEURE: Universal shall not be responsible for failure or delays in deliveries due to fire, strikes, breakdowns, acts of God, failure of carriers, inability to secure required materials, or other causes beyond Universal's control. Buyer waives any claims for damage arising by virtue of delay in delivery of material by Universal.

4) LIMITED WARRANTY:

(a) Warranty. For a period of one year from the date of manufacture, Universal warrants that each product covered by this Acknowledgment will be free from defects in material and workmanship. In order to qualify for any remedy provided in this Acknowledgment, buyer must give notice to Universal within the one-year period, return the product to Universal freight paid and intact with Material Safety Data Sheets covering all substances passing through the product or that form a residue on the product.

(b) Exclusive Remedy. The buyer's EXCLUSIVE REMEDY for failure of any product to conform to any warranty or otherwise for any defect is, at Universal's sole option: (i) repair, (ii) replacement; or (iii) refund of the entire purchase price for the specific product. Without limiting the foregoing, in no case will Universal be liable for de-installation of any defective product or installation of any repaired or replaced product. THIS REMEDY IS THE EXCLUSIVE REMEDY AVAILABLE TO THE BUYER OR ANY OTHER PERSON. UNIVERSAL SHALL NOT BE LIABLE FOR ANY DIRECT, INDIRECT, INCIDENTAL, CONSEQUENTIAL, SPECIAL, PUNITIVE, OR OTHER DAMAGES IN CONNECTION WITH ANY CAUSE OF ACTION, WHETHER IN CONTRACT, TORT, OR OTHERWISE.

(c) Disclaimer of Other Warranties. The express warranty in this Acknowledgment is in lieu of any other warranty, express or implied. Without limiting the foregoing, UNIVERSAL DISCLAIMS THE IMPLIED WARRANTY OF MERCHANTABILITY AND ANY IMPLIED WARRANTY OF FITNESS FOR A PARTICULAR PURPOSE.

(d) Special Note About Fitness for a Particular Purpose. This website and other materials of Universal may place products into, or display products in, categories according to function, size, construction, materials, or other property. This is for organizational purposes only and NO PLACEMENT OF ANY PRODUCT IN ANY CATEGORY OR ANY PRESENTATION OF A PRODUCT IN RELATION TO OTHER PRODUCTS WILL CONSTITUTE A WARRANTY OF FITNESS FOR A PARTICULAR PURPOSE.

5) PROHIBITED USES: As a condition of the sale of goods or services, buyer will not use, sell, distribute, or otherwise transfer for use, or permit to be used, sold, distributed, or otherwise transferred any product purchased from Universal for any of the following uses:

(a) Nuclear Energy Applications. Any application involving, directly or indirectly: (i) exposure of any product to any hazardous properties of nuclear material; (ii) dependence on the proper functioning of the product for the operation of a nuclear facility by any person or organization; (iii) use in or for any equipment or device used for the processing, fabricating or alloying of special nuclear material if, at any time, the total amount of such material on the premises where such equipment or device is located consists of or contains more than 25 grams of (A) Plutonium (any isotope) or Uranium 233 or any combination thereof; (B) more than 250 grams of Uranium 235; (iv) use in, or for the control of any aspect of, any structure, basin, excavation, premises or place prepared or used for the storage or disposal of waste. The foregoing include, without limitation, any application involving nuclear material contained in spent fuel or waste that is possessed, handled, used, processed, stored, transported or disposed of, any application related to the furnishing of services, materials, parts or equipment in connection with the planning, construction, maintenance, operation or use of any nuclear facility.

(b) Aircraft Applications. Any application involving direct or indirect installation in or on, or use in connection with, any aircraft or aircraft product.

(c) Definitions. As used in this section, the following definitions apply, whether the terms use initial capitals or not.

"Aircraft" includes powered and non-powered winged aircraft, missiles, spacecraft, and other aeronautical craft or mechanisms.

"Aircraft product" includes:

(1) Any ground support or control equipment used with any aircraft; (2) Any article designed for installation in or on aircraft;
(3) Any ground handling tools or equipment used with aircraft;
(4) Any aircraft training aids, instructions, manuals, or blueprints;
and

(5) Any engineering, labor or other services involving aircraft. **"Hazardous properties"** include radioactive, toxic or explosive properties;

"Nuclear facility" means

(a) Any nuclear reactor; or

(b) Any equipment or device designed or used for: (1) Separating the isotopes of uranium or plutonium; (2) Processing or utilizing spent fuel; or

(3) Handling, processing or packaging waste.

"Nuclear material" means source material, special material or by- product material;

"Nuclear reactor" means any apparatus designed or used to sustain nuclear fission in a self-supporting chain reaction or to contain a critical mass of fissionable material. **"Property damage"** includes all forms of radioactive contamination of property.

"Source material," "special nuclear material," and **"by-product material"** have the meanings given them in the Atomic Energy Act of 1954 and any regulation promulgated thereunder, as the same may be amended from time to time.

"Spent Fuel" means any fuel element or fuel component, solid or liquid that has been used or exposed to radiation in a nuclear reactor.

"Waste" means any waste material (1) containing by-product material and (2) resulting from the operation by any person or organization of any nuclear facility.